Clark County NPDES
Salmon Creek Monitoring Project

Quality Assurance Project Plan

Version 1.0 February 2003

Project Name:	Salmon Creek Monitoring Project
Project Code:	SCMP
Agency Name:	Clark County Washington
Agency Contact Name:	Jeff Schnabel
Department:	Public Works Water Resources
Funding Source:	Clark County Clean Water Fee

Approvals:

Project Manager: _____ Date: _____
Jeff Schnabel, Water Resource Scientist
Clark County Public Works Water Resources
Contact: 360-397-6118 x4583
jeff.schnabel@clark.wa.gov

Supervisor: _____ Date: _____
Rod Swanson, Monitoring Coordinator
Clark County Public Works Water Resources

Client Approval: _____ Date: _____
Earl Rowell, Water Resources Manager
Clark County Public Works Water Resources

CPU Approval: _____ Date:_____
Steve Prather, Water Quality Manager

Laboratory Contact: _____ Date: _____
Howard Holmes, Project Manager
North Creek Analytical Laboratories

QC Coordinator: _____ Date: _____
Ron Wierenga, Water Resource Scientist

Prepared by: Clark County Public Works Water Resources

Salmon Creek Monitoring Project
Quality Assurance Project Plan

Purpose of the Quality Assurance Project Plan

Clark County Public Works Water Resources (Water Resources) follows the general Quality Assurance Project Plan (QAPP) format defined by the State of Washington Department of Ecology (Ecology) (Lombard and Kirchmer, 2001). Water Resources requires a QAPP for each monitoring project. The plan addresses project design, schedule, methods of data collection and management, quality assurance and quality control requirements, data analysis, and reporting.

Background and Problem Statement

Clark Public Utilities (CPU) began water quality monitoring in the Salmon Creek watershed in 1995 to characterize conditions in the Salmon Creek main-stem and several major tributaries. Field monitoring activities were carried out by CPU staff. Data management and analysis were performed by Pacific Groundwater Group (PGG) as part of larger ongoing environmental studies funded by CPU.

In 2000, Clark County instituted the Clean Water Fee, which provides funding for expanded implementation of the county's NPDES Stormwater Management Program. As part of this implementation effort under the 1999 NPDES Permit, the county expanded its water quality monitoring activities. Among these new activities was a project begun in 2001 to evaluate the long-term health of several stormwater-influenced Clark County streams. The site list for the Long-term Index Site Project (LISP) included three sites on Salmon Creek tributaries which overlapped with the ongoing CPU water quality monitoring project (Cougar Creek, Mill Creek, and Curtin Creek). Though the county LISP studies a more comprehensive list of stream health characteristics, including habitat assessment and benthic macroinvertebrate sampling, the overlap in water quality monitoring resulted in duplicated effort.

During 2002, Water Resources and CPU signed an intergovernmental agreement (IGA) to consolidate ambient monitoring activities in Salmon Creek, standardize monitoring methods, and eliminate overlapping activities. As a result of this IGA, Water Resources assumed responsibility for collecting data for the CPU Salmon Creek monitoring project. CPU in turn agreed to provide maintenance and operation for two Clark County stream flow gages and three continuous rainfall gages (Clark County, 2002).

A general QAPP was prepared for the 1995 CPU Salmon Creek project. However, due to changes in the monitoring project and the absence of a rigorous QC protocol in the 1995 QAPP, a new QAPP was required to assure both parties that quality data are being generated.

In summary, CPU and Water Resources have an ongoing need to provide water quality data and information about the health of the Salmon Creek watershed to state and local officials. The Salmon Creek Monitoring Project (SCMP) meets the need for defensible water quality data, alleviates historical overlap in monitoring sites, and facilitates the goal of coordinating monitoring activities and protocols among local agencies.

Organization and Timeline

Project Staff

Water Resources activities are administered through Clark County Public Works as part of the county's NPDES Stormwater Management Program.

Client:	Earl Rowell, Water Resources Manager
Supervisor:	Rod Swanson, Senior Planner
Project Manager:	Jeff Schnabel, Water Resource Scientist
QC Coordinator:	Ron Wierenga, Water Resource Scientist
Project Team:	Bob Hutton, Planner III
	Jeff Schnabel
	Ron Wierenga

Laboratory Contracts

Laboratory water quality analyses for the project are performed by North Creek Analytical Laboratories (NCA), an Ecology-accredited laboratory located in Beaverton, Oregon.

Laboratory:	North Creek Analytical Laboratory
Address:	9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
Phone:	503-906-9200
Contact:	Howard Holmes

Budget

Budget estimates for the SCMP are found in Table 1:

Budget Category	Estimated Cost (annual)
Staff	$8,500.00
Vehicle	$250.00
Laboratory	$13,750.00
Total	**$22,500.00**

Table 1. Annual budget estimates for the Water Resources SCMP.

Project Timeline

The SCMP is an ongoing ambient monitoring project. Under the IGA with CPU, Water Resources began monitoring in May 2002. Data collection activities by Water Resources will continue until the SCMP project is revised or discontinued by agreement between CPU and Water Resources. Water Resources data are submitted to CPU on a monthly basis for analysis. Brief annual project reports including methods, data, and QC results will be submitted by Water Resources to CPU beginning with the year 2003 report due in March 2004.

Project Description

The intent of the SCMP is to provide high-quality data and water quality information about the Salmon Creek watershed to Clark Public Utilities and Clark County decision-makers. Within this context, data are used for a variety of purposes, including:

- Annual report of Salmon Creek water quality by Clark Public Utilities

- Watershed management by CPU, Clark County, and other local entities
- 303(d) data submittals to Ecology
- Clark County Stream Health Report

Objectives

Specific project objectives are to:

- Provide CPU and Clark County with timely, high-quality data that are comparable to those collected by other local and regional agencies.
- Determine whether water quality at sampling stations exceeds state standards.
- Provide Clark County decision-makers and the general public with analytical information that describes water quality status in the Salmon Creek watershed.

Sampling Design

Station Selection

Sampling stations for the original CPU monitoring project in 1995 were selected to match the stations used in earlier Salmon Creek studies conducted by Clark County (1989-1990 and 1991-1994). Four stations are located along the main stem of Salmon Creek and four additional stations are located near the mouths of major tributaries: Cougar Creek, Mill Creek, Curtin Creek, and Woodin Creek. Stations are located at road crossings to facilitate convenient sampling.

All SCMP stations remain in the same locations as the original CPU stations, except that CPU Site 4 (Salmon Creek abv Mill Cr) has been relocated approximately 500 yards upstream to NW 50th Ave for easier access. Figure 1 shows the locations of the eight SCMP monitoring stations. Table 2 contains station names and descriptions from the original CPU project and the SCMP. SCMP sites have been assigned station names consistent with Water Resources' county-wide naming conventions.

Original CPU Project Station Name	Description	SCMP Station Name	Description
CPU Site 1	Salmon Cr. @ NW 36th Ave	SMN010	Salmon Cr. @ NW 36th Ave
CPU Site 2	Cougar Cr. @ NE 119th St	CGR020	Cougar Cr. @ NE 119th St
CPU Site 3	Salmon Cr. abv Mill Cr.	SMN030	Salmon Cr. @ NW 50th Ave
CPU Site 4	Mill Cr. @ Salmon Cr. Rd	MIL010	Mill Cr. @ Salmon Cr. Rd
CPU Site 5	Curtin Cr. @ NE 139th St	CUR020	Curtin Cr. @ NE 139th St
CPU Site 6	Salmon Cr. @ NE 122nd Ave	SMN050	Salmon Cr. @ Caples Rd.
CPU Site 7	Woodin Cr. @ NE 122nd Ave	WDN010	Woodin Cr. @ Caples Rd.
CPU Site 8	Salmon Cr. @ NE 199th St	SMN080	Salmon Cr. @ NE 199th St

Table 2. Station names and location from the original CPU Salmon Creek project and the Water Resources SCMP.

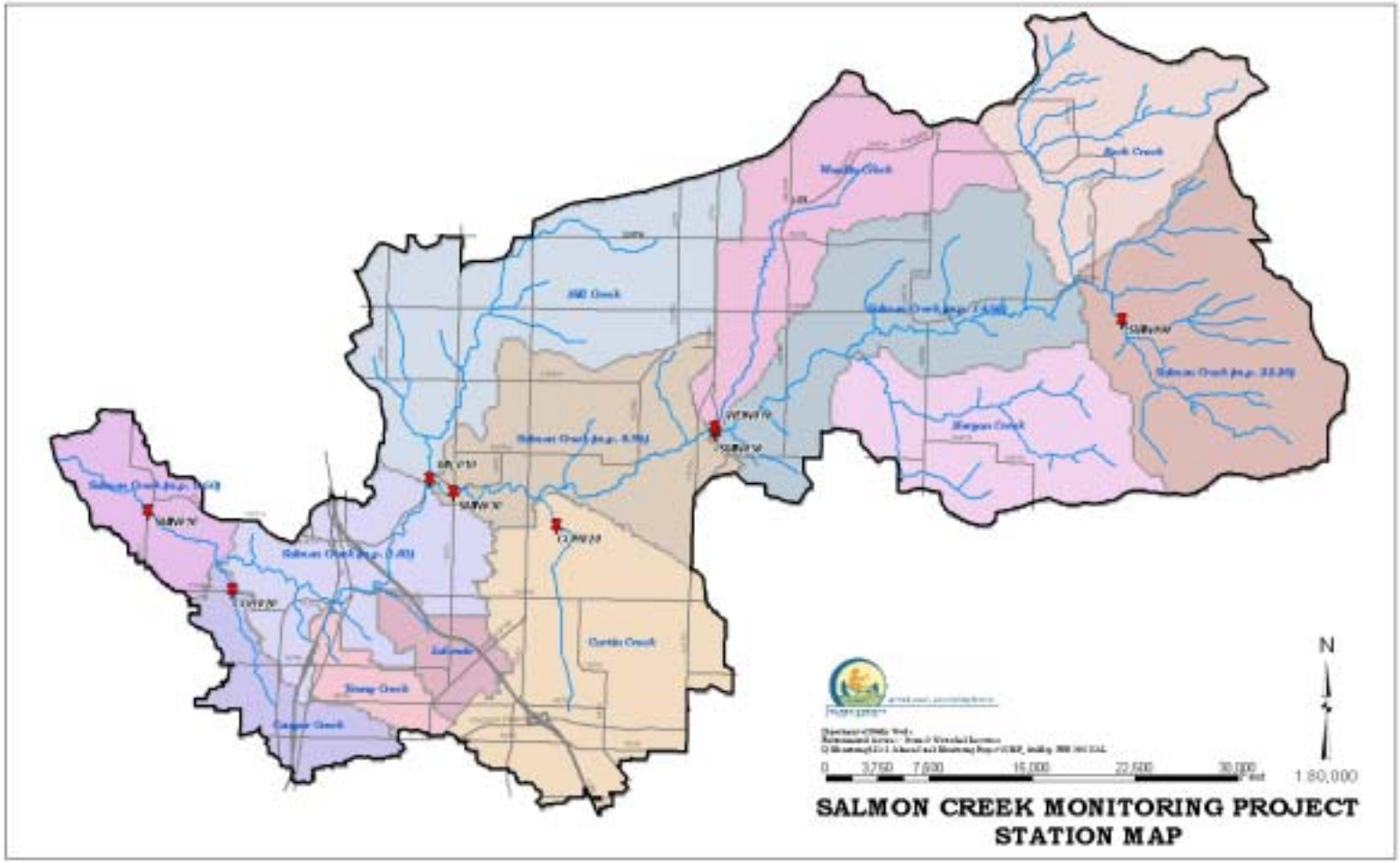

Figure 1. Location of the eight SCMP monitoring sites

Sampling Schedule

Physicochemical water quality characteristics are sampled at each of the eight sites during monthly grab sampling events. Stage measurements are recorded monthly at the CGR020, MIL010, CUR020, and WDN010 sites. Monthly sampling dates are randomly selected.

Table 3 summarizes the water quality characteristics, sampling frequency, and sample types used in the SCMP.

Characteristic	Frequency	Sample Type
Temperature, water	monthly	field meter
Dissolved oxygen	monthly	field meter
pH	monthly	field meter
Conductivity	monthly	field meter
Turbidity	monthly	field meter
Total solids	monthly	grab
Ammonia	monthly	grab
Nitrate + nitrite	monthly	grab
Total phosphorus	monthly	grab
Fecal coliform/E.coli	monthly	grab
Stage	monthly	instantaneous

Table 3. Characteristics, schedule, and sample type.

Representativeness

SCMP data are intended to be representative of conditions at each sample station. Water Resources utilizes standard monitoring procedures which are designed to facilitate the collection of representative samples. Sampling on randomly-selected dates, sampling from within the thalweg, sampling well-mixed tributary flow, and utilizing standard procedures all facilitate the collection of representative samples.

The time of day when samples are collected is determined by the logistics of visiting all stations on a single day and coordinating with the laboratory for timely analysis of samples. However, in most cases sampling is performed following a standard route and at approximately the same time during each trip to minimize diurnal effects on characteristics which show large diurnal variations (temperature, pH, and dissolved oxygen).

Data Comparability

One of the objectives of the SCMP is to gather data that are comparable to other local and regional data. Long-term comparability of SCMP data with other data is facilitated by utilizing and documenting standard procedures for data collection and analyses.

The SCMP utilizes the same suite of water quality characteristics as the county's LISP, and has been modified somewhat from the characteristics studied in the original CPU Salmon Creek project. SCMP data will be comparable with current and future county and CPU monitoring.

However, since the dataset from the original CPU project is not identical to the SCMP, the period of record for certain CPU project characteristics ended in June 2002 when the SCMP was initiated. The Appendix contains a table comparing the water quality characteristics studied in the SCMP and the original CPU project.

Quality Objectives

Measurement Quality Objectives

Analytical methods, detection or precision limits, and Measurement Quality Objectives (MQO) for accuracy, precision, and bias are listed in Table 4. MQOs for the SCMP are set at generally accepted targets for ambient water quality monitoring projects. Data quality objectives and quality control procedures for laboratory parameters are detailed in NCAs quality assurance documents (November, 2001).

Collection, preservation, transportation, and storage of samples follow standard procedures designed to reduce most sources of sampling bias. Analytical bias is minimized by adherence to the methods listed in Table 4. The laboratory employs quality control procedures appropriate to the analytical procedures, including analysis of method blanks, matrix spikes, and check standards.

Characteristic	Method	Resolution/ Reporting Limit	Accuracy	Precision	Bias	Reference
		conc./ units	Units / % error	%RSD	%REC	lab
Temperature (grab)	Thermistor	0.01 C	± 0.15 °C	NA	NA	
Dissolved oxygen	Membrane electrode	0.01 mg/L	± 0.2 mg/l	NA	NA	
pH	Glass electrode	0.01 units	± 0.2 pH units	NA	NA	
Conductivity	Electrode	4 digits	± 0.5% of reading	NA	NA	
Turbidity (field) (lab)	Nephelometric Nephelometric	0.01 NTU 0.20 NTU	± 2% of reading 25%	NA 10%	NA 5%	 EPA 180.1
Total solids	Total residue	10.0 mg/L	25%	10%	5%	EPA 160.3
Ammonia	Colorimetric	0.05 mg/L	25%	10%	5%	EPA 350.1
Nitrate + nitrite	Colorometric/ Cadmium	0.01 mg/L	25%	10%	5%	EPA 353.2
Total phosphorus	Colorometric	0.02 mg/L	25%	10%	5%	EPA 365.1
Fecal coliform	Most Prob Number	2 MPN/100 mL	NA	28%	NA	*SM 9221
E.coli	Most Prob Number	1 MPN/100 mL	NA	28%	NA	*SM 9223B
*Guidelines Establishing Test Procedures for the Analysis of Pollutants; Analytical Methods for Biological Pollutants in Ambient Water; Proposed Rule						

Table 4. SCMP analytical methods and detection or precision limits.

Field Procedures

Equipment calibration, quality assurance, and field data collection protocols for all data collected by the SCMP are described in: Standard Procedures for Monitoring Activities: Clark County Water Resources Section (2002). All field activities are conducted by 2-person field crews.

Sample containers for laboratory delivery are labeled in indelible ink with the following information:

- Clark County
- SCMP
- Station Name
- Date
- Time

Water quality samples are collected in properly preserved bottles prepared by the laboratory, and stored on ice or refrigerated until delivery to NCA. Water quality samples are picked up by laboratory personnel within 24 hours of collection. Formal Chain of Custody documentation is maintained for all samples sent to NCA.

Logs are kept of all field activities. Logs may consist of standardized field sheets as well as bound log books containing ancillary data and observations. Logs are waterproof and entries made with pencil or indelible ink. Corrections are made by drawing a single line through the error such that it remains legible, writing the correction adjacent to the error, and initialing the correction.

Records are cross-checked for consistency between labels, custody documents, data sheets, field logs, and other relevant data. Log books are archived in Water Resources files.

Laboratory Procedures

Ammonia, nitrate + nitrite, total phosphorus, total solids, and bacteria analyses are conducted by NCA. Turbidity samples may be analyzed either in the field or by NCA. All procedures are performed according to NCA's Ecology-approved quality assurance program and according to accepted conventions for data manipulation and reporting as described in Standard Methods (APHA, 1992). Table 4 shows the constituents measured, analytical methods, and reporting limits.

Quality Control

Laboratory QC

Laboratory check standards, matrix spikes, analytical duplicates, and blanks are analyzed in accordance with the NCA Quality Assurance Program. All QC results are reported to Water Resources staff along with sample data. Laboratory data reduction, review, and reporting are performed according to the NCA Quality Assurance Program. Data are assessed and reported according to the methods described in the NCA Quality Assurance Program.

Field QC

Field QC sample types, frequencies, and definitions for SCMP monthly water quality samples are found in Table 5. A standard 10% duplication rate is used for laboratory water quality samples and field meter measurements, except for bacteria samples which are duplicated at a rate of 20%. Transfer blanks are collected quarterly, and a transport blank is collected annually. Paired turbidity samples are collected semi-annually to compare field meter readings with laboratory measurements.

All meters are calibrated and maintained in accordance with the manufacturer's instructions. Check standards for conductivity and turbidity are used to verify the accuracy of field meters. An NIST-certified thermometer is used to verify the accuracy of temperature sensors. Calibration logs are completed during each calibration and are archived in Water Resources files. Calibration drift in pH meters is checked against pH buffer solutions and dissolved oxygen measurements are verified using a modified Winkler titration in the field. These activities are used to confirm that field instruments are attaining stated accuracy and resolution specifications.

Field QC sample type	Frequency	Definition
Field measurement replicate	10% of samples	repeat field meter measurements
Sample duplicate (bacteria) (all other)	 20% of samples 10% of samples	duplicate sample collected for laboratory analysis
Transfer blank	Quarterly	D.I. water sample collected in field with sampling equipment
Transport blank	Annually	D.I. water sample prepared in office and carried through field trip
Paired lab sample	Semi-annually	turbidity sample analyzed with field meter, and second sample submitted for lab analysis

Table 5. SCMP QC sample types, frequencies, and definitions.

Corrective Actions

Data quality problems encountered in the analysis of QC samples are addressed as needed through re-calibration, modifications to the field procedures, increased staff training, or by qualifying results appropriately. Documentation of corrective action steps includes problem identification, investigation procedures, corrective action taken, and effectiveness of the corrective action.

Data Management Procedures

Data management procedures for the SCMP will be revised as the project matures and as Water Resources develops a centralized data storage and retrieval system. In the interim, data management procedures for the SCMP are as follows:

Data are stored in an Excel spreadsheet at Water Resources, along with digital backup copies of laboratory reports. Hard copies of laboratory reports are stored in a project binder. Digital files are backed up on CD on an annual basis, and laboratory data packets are also archived on the county's Digital Imaging System. QC data, including field measurement replicates, sample duplicates, transfer and transport blanks, paired samples, and field checks for pH and dissolved oxygen, are stored in Excel spreadsheets at Water Resources. The QC coordinator and project manager are responsible for validating and cross-checking data entry.

Laboratory data are reported by NCA in both digital and hard copy formats. Laboratory data and field measurements are entered manually. Manually entered data are cross-checked by the project manager and/or QC coordinator for entry errors. The laboratory data package includes QC results and an explanation of any necessary data qualifiers.

Audits and Reports

Audits

The project manager and QC coordinator periodically review the field data, methods, lab results, and data management activities to make an assessment of the program and identify corrective actions or method revisions.

Reports

Data are reported to CPU on a monthly basis. Data are sent via e-mail to John Louderback of CPU. Data analysis and reporting for CPU are performed by PGG.

Annual data summaries compiled by Water Resources address project methods, summarize data accuracy and completeness, describe any significant data quality problems, and suggest modifications for future monitoring. Reports are peer reviewed by Water Resources staff. SCMP summaries are generally incorporated as attachments to the county's annual NPDES permit compliance report to Ecology. Executive summaries, and full reports as warranted, are placed on the county's website to facilitate dissemination of information to the public.

The suite of SCMP water quality characteristics are used by Water Resources to assess current condition by comparing the data with established state standards and criteria. The monitored characteristics were also selected to allow calculation of the Oregon Water Quality Index (OWQI). OWQI parameters include temperature, dissolved oxygen, pH, ammonia, nitrate + nitrite nitrogen, total phosphorus, total solids, and fecal coliform bacteria. Biochemical oxygen demand (BOD) is also included in the OWQI, but will not be analyzed in this project. The OWQI is a useful reporting tool for summarizing large amounts of water quality data, and provides for regional comparisons with other monitoring projects.

Data Review, Verification, and Validation

During each sample trip, field crews review field and sample logs to confirm that all necessary field measurements and samples have been collected. Laboratory QC results are reviewed and verified by NCA staff and documented in data reports to Water Resources. Upon receipt, laboratory data are reviewed for errors, omissions, and data qualifiers prior to data entry.

Data verification involves examination of QC results analyzed during the project to provide an indication of whether the precision and bias MQOs have been met. To evaluate whether precision targets have been met, pairs of duplicate sample results are pooled and an estimate of standard deviation is calculated. This estimate, divided by the mean concentration of the duplicate results and converted to percent, is used to judge whether the %RSD target has been met.

To evaluate whether bias targets have been met, the mean percent recovery of the check standards should be within +/- %bias target of the true value (e.g. true value +/- 10%). Unusually high blank results indicate bias due to contamination that may affect low-level results. To evaluate whether the target for reporting limit has been met, results will be examined to determine if any of the values exceed the required reporting limits.

Data validation consists of a detailed examination of the complete data package using professional judgement to assess whether the procedures in the SP's and QAPP have been

followed. Data validation is performed by the project manager and QC coordinator during the preparation of annual reports to CPU.

Data Quality Assessment

Taking into account the results of data review, verification, and validation, an assessment will be made as to whether the data are of sufficient quality to attain project objectives.

References

APHA (1992). *Standard Methods for the Examination of Water and Wastewater, 18th ed.*

Clark County Public Works, Water Resources Section (2002). *Agreement for Services* between Clark County and Clark Public Utilities.

Clark County Public Works, Water Resources Section. (June 2002). *Standard Procedures for Monitoring Activities, Clark County Water Resources Section.*

Lombard, S. and C. Kirchmer. (February 2001). *Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies.* Washington State Department of Ecology. Publication No. 01-03-003, revision of Publication No. 91-16.

North Creek Analytical, Inc., 2001. *Quality Assurance Manual, Beaverton, Revision 13.0.* Beaverton, Oregon.

APPENDIX

1995 CPU Salmon Creek Project	2003 Water Resources SCMP
Temperature	Temperature
Conductivity	Conductivity
pH	pH
Dissolved oxygen	Dissolved oxygen
Total suspended solids	
Fecal coliform	Fecal coliform
Total Kjeldahl nitrogen	
Nitrate-nitrogen	Nitrate + nitrite nitrogen
Nitrite	
Ammonia	Ammonia
Soluble reactive phosphorus	
Total phosphorus	Total phosphorus
Chloride	
Sulfate	
	E. coli
	Turbidity

Table X. Comparison of monitored characteristics in 1995 CPU Salmon Creek Project and 2003 Water Resources SCMP